Semiannual Status Report No. 3

STUDY OF THE CARBON DIOXIDE SPECTRUM OF MARS AND VENUS

Grant No. NGR 09-015-047
National Aeronautics and Space Administration

for the period
November 1, 1967 through April 30, 1968

Principal Investigator
Dr. N. P. Carleton

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During the period covered by this report we have worked on the following aspects of our program:

1. Completion of the analysis of our measurements of CO_2 absorption on Mars made in April 1967;

2. A search for the 6300 Å oxygen line in the dayglow of Venus;

3. Laboratory spectroscopic work to determine properties of the methane spectrum that will allow us to make accurate thermometric measurements on portions of Jupiter's disk;

4. Construction of a PEPSIOS interferometric spectrometer.

I shall summarize our work on these in order.

Our analysis of the Martian CO_2 abundance is now complete, and a manuscript (~~see copy attached~~) has been submitted to the Astrophysical Journal. The abstract is printed below:

> High-resolution measurements have been made of CO_2 absorption on Mars, in the $\nu_1 + 2\nu_2 + 3\nu_3$ band at 1.05μ. The instrument used was a PEPSIOS three-etalon Fabry-Perot spectrometer that accepted light from a circle 0.447 times the diameter of the planetary image during the 1967 opposition. The results for the CO_2 abundance a_0 (in m-atm) can be summarized by the relation $a_0 = (84 \pm 6) - 0.2\ (T - 195) - 1.0\ (p - 7)$, where T is the effective average temperature in degrees Kelvin, and p is the surface pressure in mb. The value 83 ± 8 m-atm is believed to be the best

estimate of CO_2 abundance, corresponding to a partial surface pressure of CO_2 of 6.1 mb. The composition of the Martian atmosphere is judged to be between 60% and 100% CO_2 corresponding to a range of 9 mb to 6 mb in surface pressure. No variation in the observed equivalent line widths with Martian longitude was observed.

We are continuing our study to see how a rotational temperature analysis of absorption in a nonisothermal planetary atmosphere can be used in constructing curves of growth for the individual lines. We are numerically constructing synthetic spectra from models of the Martian atmosphere, devised by Gierasch and Goody, to see in particular whether an effective temperature can be simply derived so as to be a meaningful parameter for the curve of growth.

We also obtained CO_2 absorption spectra of Venus, which will be used in a program of analysis developed by Goody and Regas to describe line formation in an atmosphere containing scattering particles.

A byproduct of our work on CO_2 was a brief search for CO_2 absorption in the spectrum of a cool star, α Herculis. We saw no absorption and described the limit we could set in a short paper accepted by the *Astrophysical Journal*.

Our investigation of the spectrum of Venus for the 6300 Å oxygen line was motivated by a desire to understand the absence of any great amount of oxygen in the Venusian atmosphere, in spite of the rapid photodissociation of CO_2. McElroy and others have suggested that the photodissociated atoms (which are in the ^1D state) may react rapidly with CO_2 to form a CO_3 complex, which then reacts with CO. Knowledge of the absolute concentration of $O(^1D)$ would be very helpful in the assessment of the importance of these reactions; this information can be obtained from an absolute measurement of the intensity of the 6300 Å line. If we could see the line with an intensity of 50 kR, or set this as an upper limit, the results would be interesting. To observe such a line intensity amongst the reflected solar continuum is a problem comparable to the direct observations of 6300 Å in the terrestrial dayglow, which has been done by Shepherd. We made some measurements, but reached a limit that was only around 150 kR, since we had to do most of our observing during daylight hours with bad seeing conditions, a factor that introduced considerable noise. We shall continue these measurements near the next maximum elongation of Venus, in the winter of 1968-69.

We are planning a program of detailed measurement of molecular rotational temperatures as a function of position on Jupiter's disk. We would like to work at a wavelength as short as possible in order to use detectors of good quantum efficiency, and thus to obtain information with high spectral and spatial resolution in a reasonable length of time. The bands of methane in the visible region of the spectrum would be most useful for this purpose, but unfortunately they have not been analyzed. We are taking some preliminary spectra of methane in the visible; Dr. Kenneth Fox (of JPL, Cal. Tech., and Tennessee) has agreed to look at these. We also hope that Dr. Plyler of Florida State will be supported in some further work on these methane bands. We are also taking some photographic spectra of the same bands in the spectrum of Jupiter, at fairly high resolution.

We are constructing a PEPSIOS interferometer for use at the Agassiz Station of Harvard College Observatory and (by Spring 1969) at the new SAO 60-in. telescope at Mt. Hopkins in Arizona. So far our actual construction has been mainly on the data-handling system, improving the flexibility of our present system and replacing some borrowed elements. We expect to complete our design of a pressure-control system for the etalon chambers within 2 months or so.

In closing, I might mention also that for the past few weeks I have been using some of our data-handling system to record visible light from the neighborhood of two of the so-called pulsars. We have possibly detected fluctuations of light at subharmonics of the radio-pulse repetition frequency, but can rule out to fairly high precision that there is an optical pulsation similar in form to the radio pulses.